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(54) **LIGHT-EMITTING SEMICONDUCTOR CHIP AND OPTOELECTRONIC COMPONENT**

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H01L 33/60 (2010.01)

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CPC ***H01L 33/483*** (2013.01); ***H01L 33/50*** (2013.01); ***H01L 33/56*** (2013.01); ***H01L 33/60*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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(57) **ABSTRACT**

A light-emitting semiconductor chip comprises: a radiation-transmissive substrate, an epitaxially grown semiconductor layer sequence on a main surface of the substrate, a first contact and a second contact on a contact surface of the semiconductor layer sequence facing away from the substrate for electrical and mechanical contacting of the semiconductor chip, a transparent, electrically conductive layer which is arranged on the contact side and is electrically connected to the first contact.

15 Claims, 3 Drawing Sheets

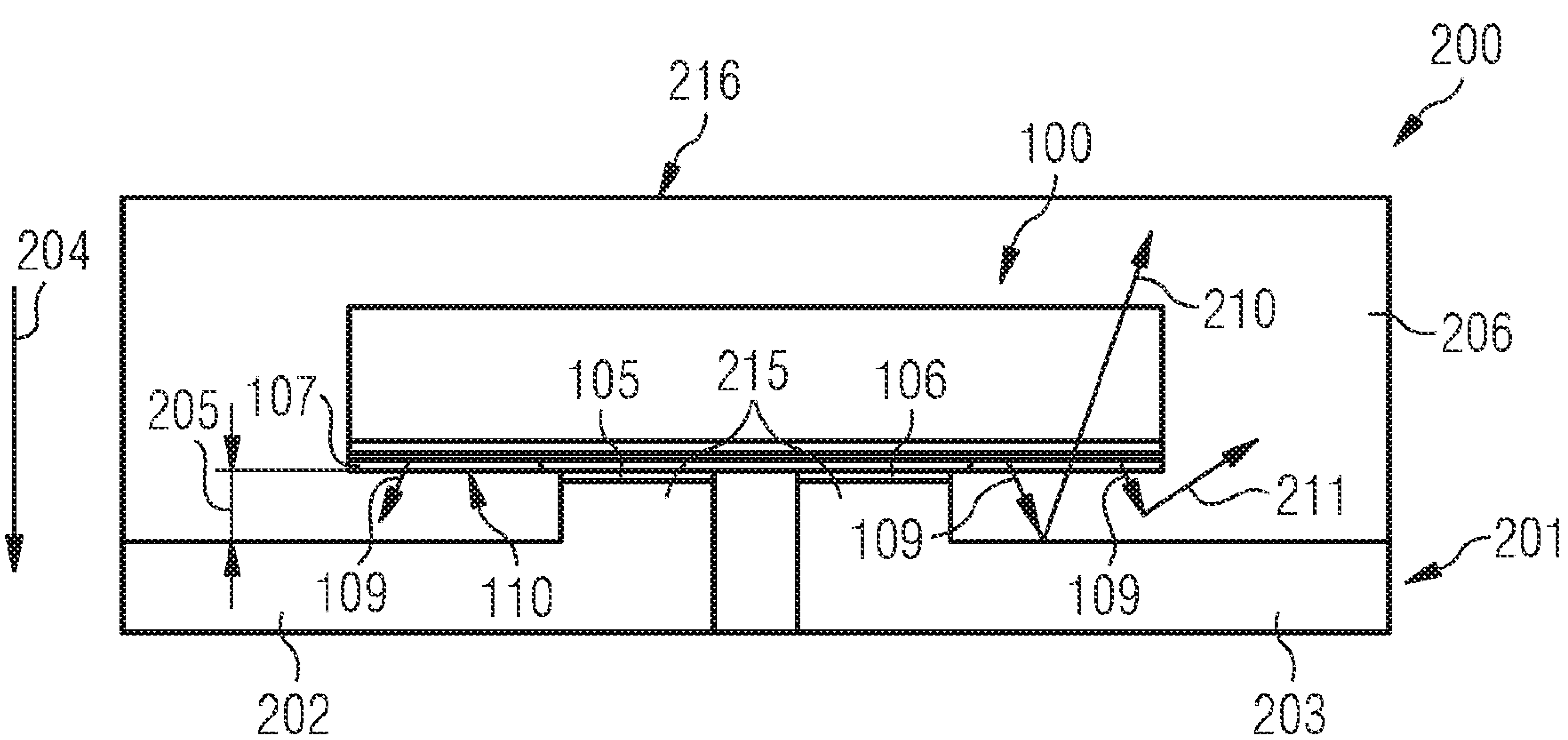


FIG 1

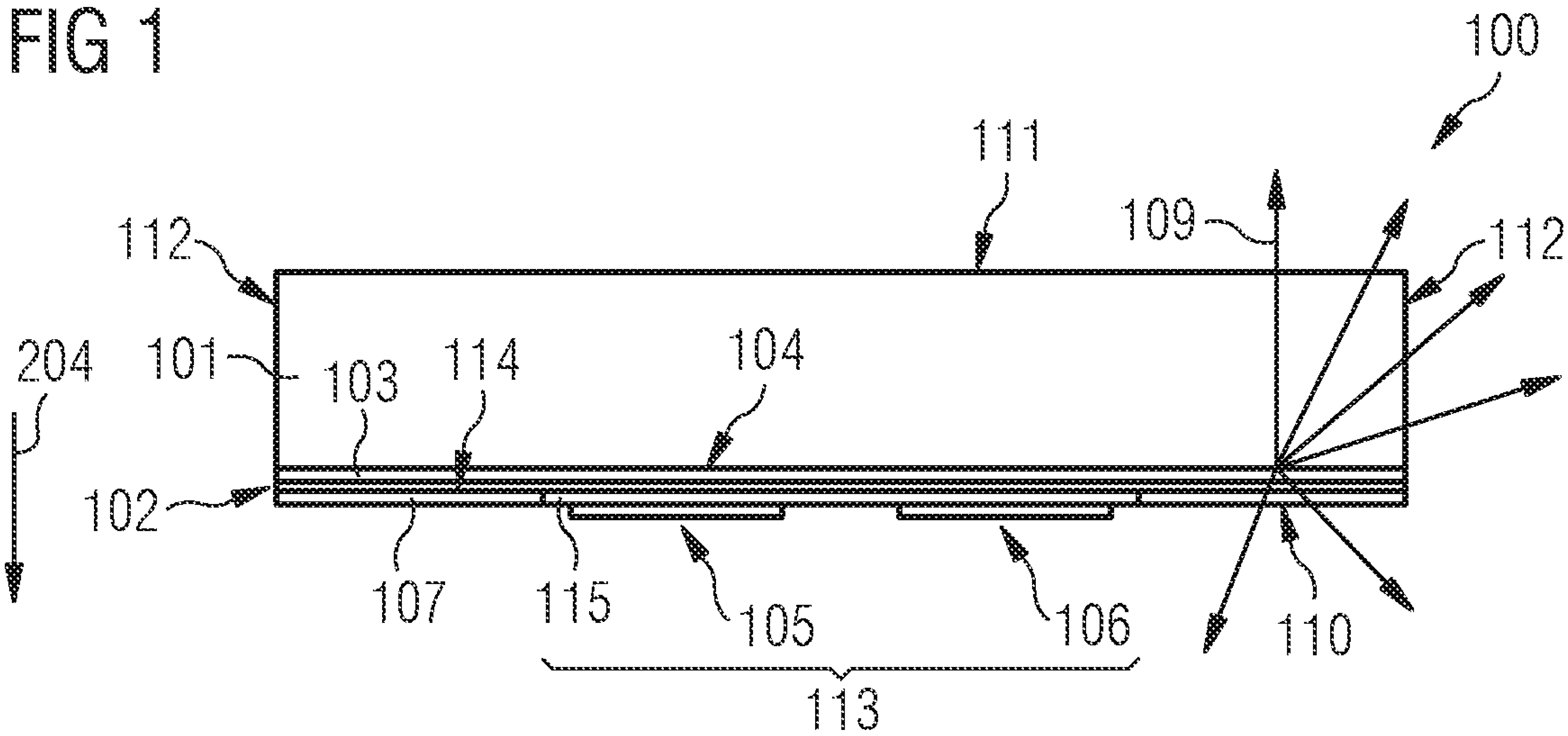


FIG 2

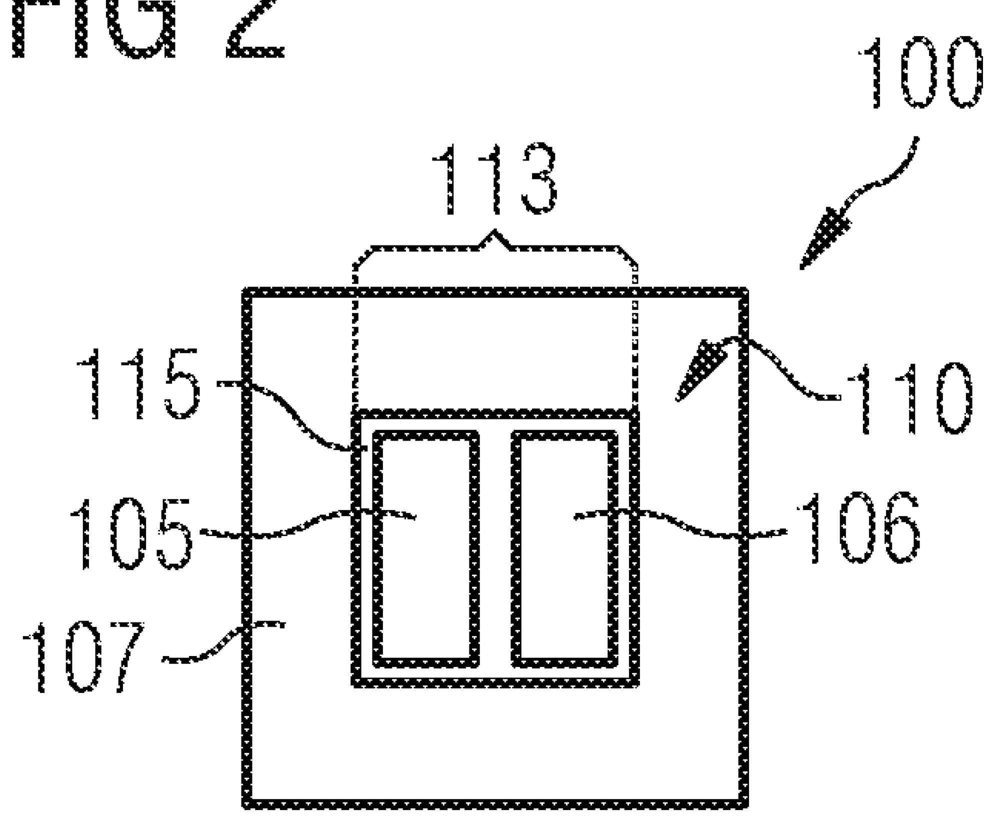


FIG 3

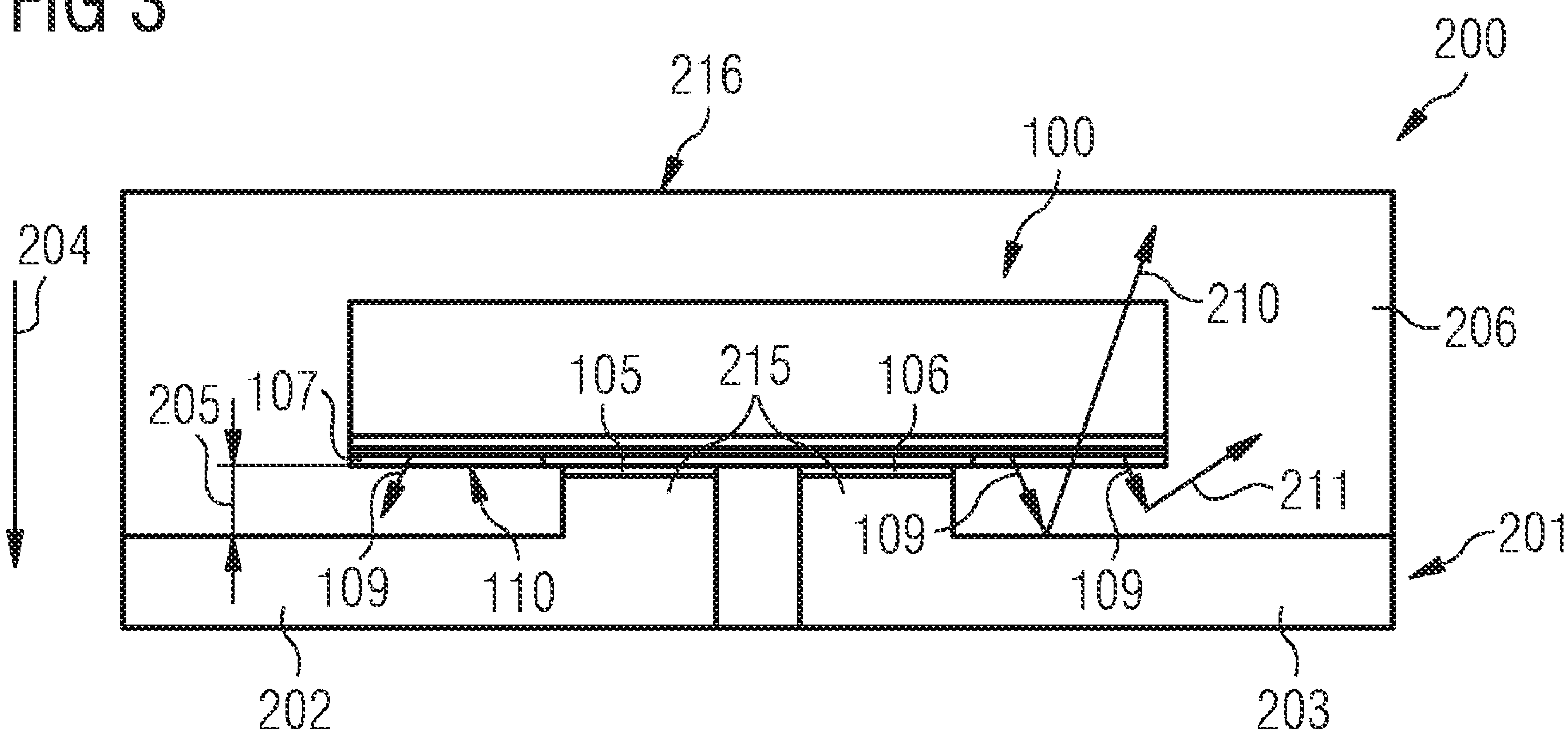
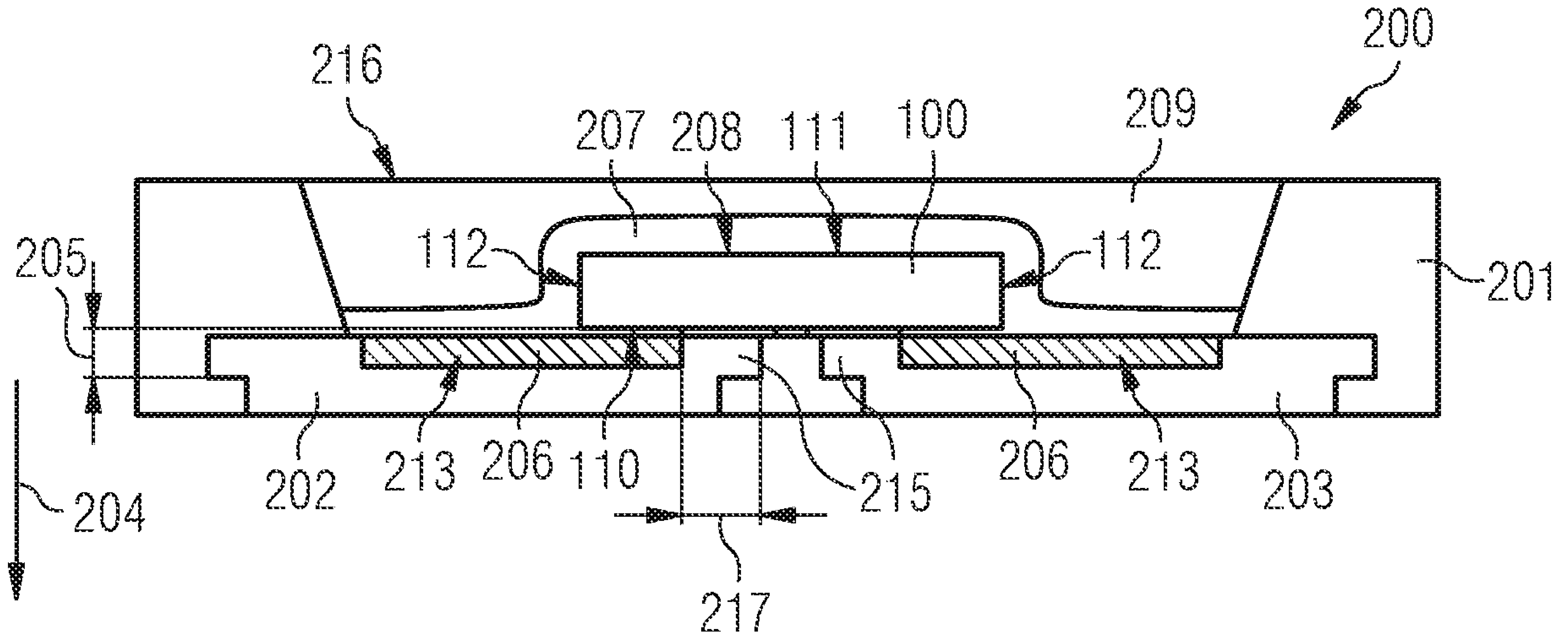
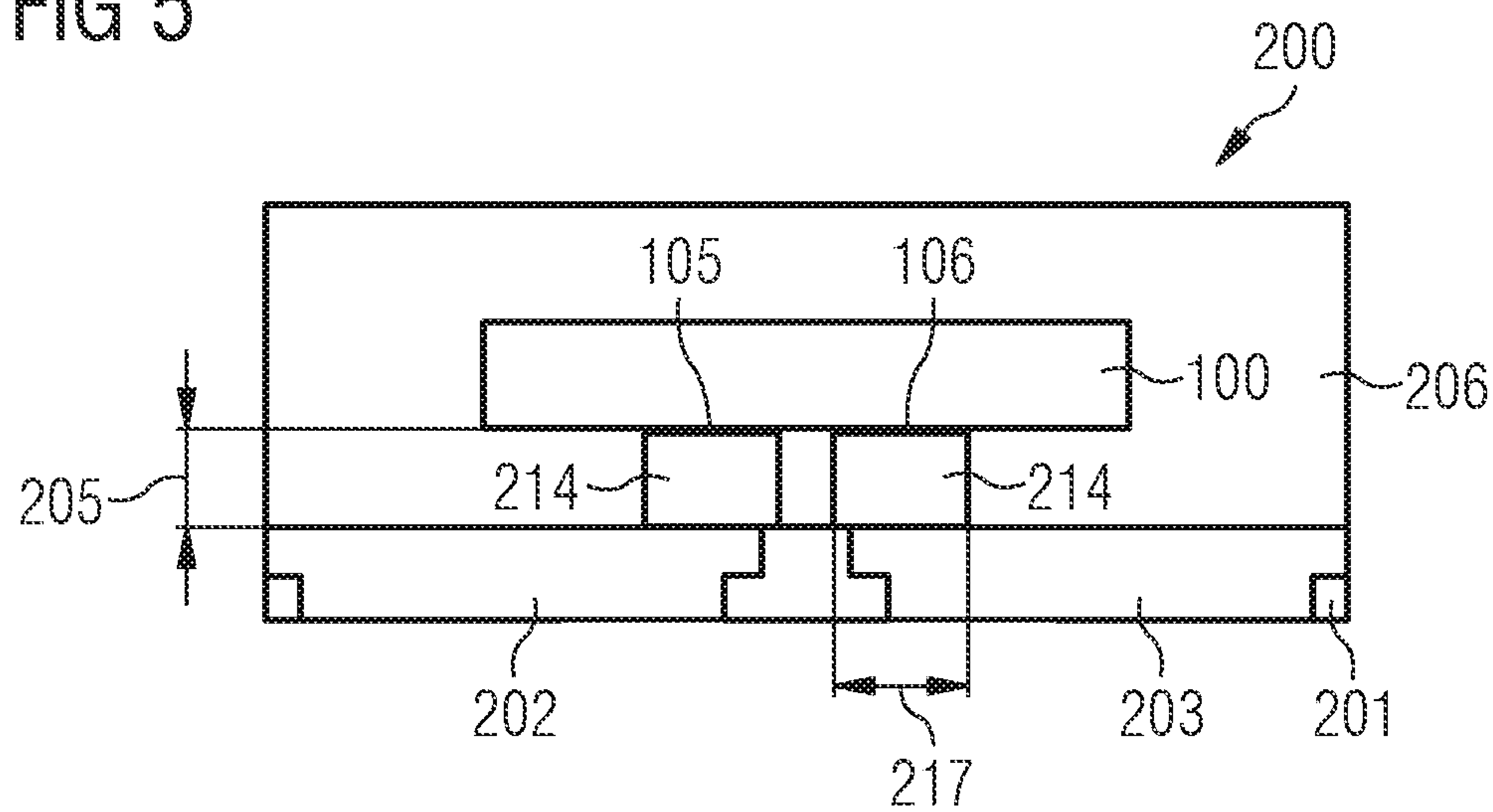


FIG 4



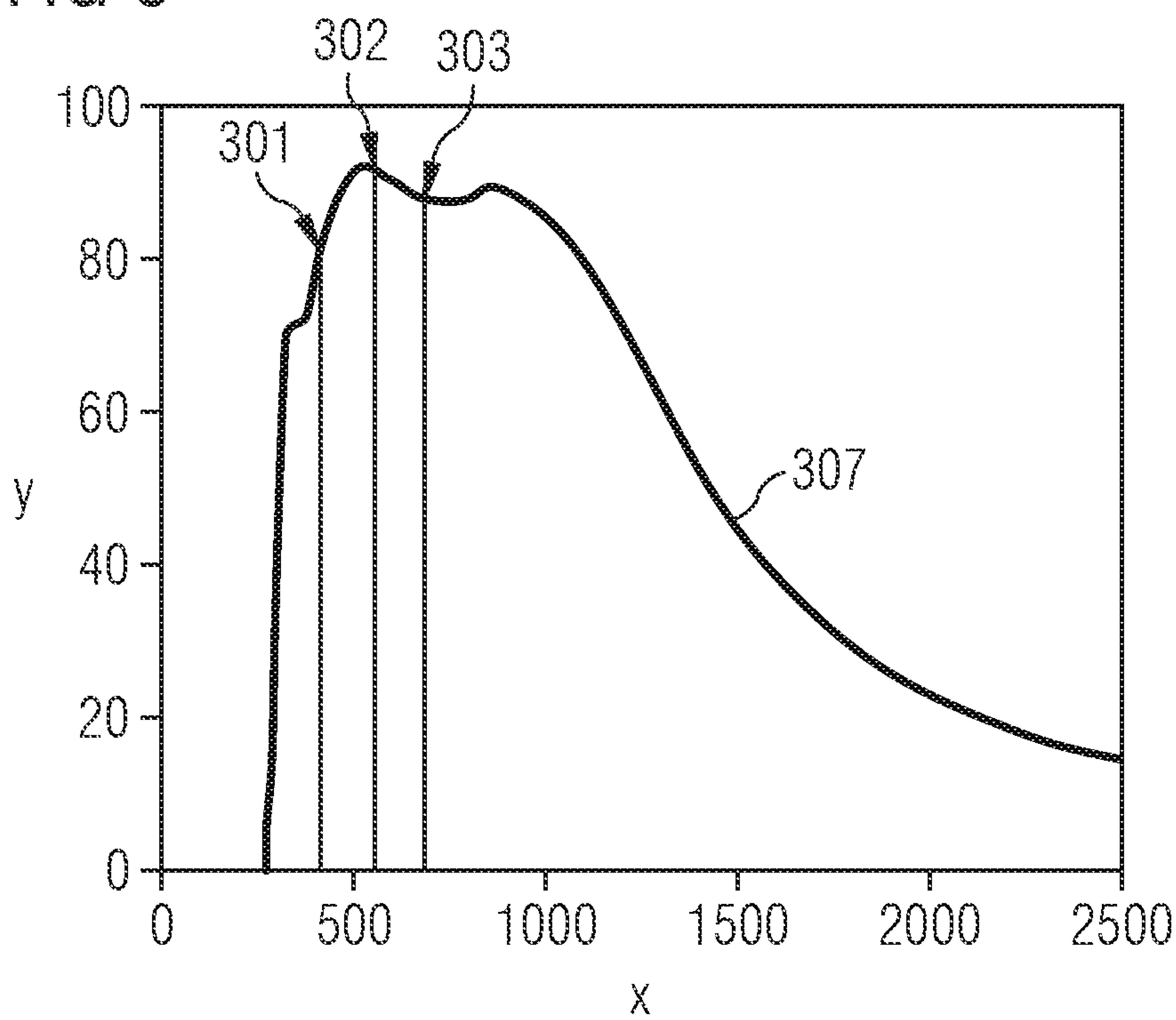
200
216
207
208
111
100
209
205
112
112
201
202
213
206
110
215
206
213
203
204
217

FIG 5



200
105
106
100
206
205
214
214
202
203
201
217

FIG 6



LIGHT-EMITTING SEMICONDUCTOR CHIP AND OPTOELECTRONIC COMPONENT

This patent application claims the priority of the German Patent Application 10 2017 117 504.0, the disclosure of which is hereby incorporated by reference.

The application relates to a light-emitting semiconductor chip and an optoelectronic component with such a semiconductor chip.

It is desirable to provide a semiconductor chip and an optoelectronic device that enables efficient operation.

According to an embodiment, a light-emitting semiconductor chip has a radiation-transmissive substrate. The substrate is, for example, a sapphire substrate. According to further embodiments, the substrate is made of a different material. The substrate is, for example, a growth substrate. The substrate is a carrier substrate according to further embodiments. The radiation-transmissive substrate is formed in particular from a material and with a layer thickness such that the substrate has a transmittance of at least 60%, 70%, 80% or at least 90% with respect to a wavelength of an electromagnetic radiation generated during operation of the semiconductor chip. In particular, light in the visible range, as well as in the adjacent ultraviolet and infrared range, is absorbed as little as possible by the substrate. In particular, the substrate has a transmittance of at least 60%, 70% or 80% or at least 90% for these wavelength ranges.

According to an embodiment, the light-emitting semiconductor chip has an epitaxially grown semiconductor layer sequence on a main surface of the substrate. The semiconductor layer sequence has, for example, a p-type semiconductor layer and an n-type semiconductor layer. In a vertical direction, also called growth direction, an active layer is arranged between the p-type semiconductor layer and the n-type semiconductor layer, for example. The active layer is, for example, a pn-junction.

For example, the semiconductor layer sequence is based on gallium nitride, indium gallium nitride, or another material such as gallium arsenide. During operation of the semiconductor chip, the semiconductor layer sequence is in particular configured to emit the electromagnetic radiation in the visible, ultraviolet or infrared spectral range. For example, the semiconductor chip is a light emitting diode (LED).

According to an embodiment, the semiconductor layer sequence is grown on the substrate. The substrate is thus the growth substrate of the semiconductor layer sequence. According to a further embodiment, the semiconductor layer sequence is first grown on another substrate and subsequently applied to the substrate. The substrate then not the growth substrate, but the carrier substrate.

According to an embodiment, the light-emitting semiconductor chip has a first contact and a second contact on a contact side of the semiconductor layer sequence facing away from the substrate for the electrical and mechanical contacting of the semiconductor chip. The first contact is, for example, electrically conductively connected to the n-conducting layer of the semiconductor layer sequence. The second contact is, for example, electrically conductively connected to the p-type layer of the semiconductor layer sequence. The first and the second contact serve to provide a connection an external current/voltage source to the light-emitting semiconductor chip during operation. For example, the first and the second contact are adapted to be electrically conductively connected to conductors of a carrier, also called a leadframe. The first and/or the second contact comprise, according to an embodiment, a plurality of layers of a dielectric material and an electrically conductive metal, such as silver. In particular, the first and/or the second contact are each designed to be reflective at least on a side facing the substrate, in particular for the radiation emitted by the semiconductor layer sequence.

According to an embodiment, the light-emitting semiconductor chip has a transparent, electrically conductive layer. The transparent, electrically conductive layer is arranged in particular on the contact side. The transparent, electrically conductive layer is electrically connected to the first contact.

The transparent, electrically conductive layer is, for example, a transparent, electrically conductive oxide (also called TCO). For example, the layer is of indium tin oxide. The electrically conductive layer serves, for example, for connecting the first contact to the semiconductor layer sequence. By means of the electrically conductive layer, moreover, the semiconductor layer sequence is supplied with current or voltage on a surface which is larger than the surface of the contacts.

The transparent, electrically conductive layer is in particular transparent to electromagnetic radiation in the visible, infrared and/or ultraviolet range. With regard to a peak wavelength of the electromagnetic radiation generated during operation of the semiconductor layer sequence, the electrically conductive layer has a transmittance of at least 60%, 70%, 80% or at least 90%.

The transparent electrically conductive layer may also be referred to as a current spreading layer.

According to an embodiment, a light-emitting semiconductor chip has a radiation-transmissive substrate. The semiconductor chip has an epitaxially grown semiconductor layer sequence on a main surface of the substrate. The semiconductor chip has a first contact and a second contact on a contact side of the semiconductor layer sequence facing away from the substrate. The first contact and the second contact each are used for electrical and mechanical contacting of the semiconductor chip. The semiconductor chip has a transparent, electrically conductive layer. The transparent electrically conductive layer is disposed on the contact side and electrically connected to the first contact.

According to an embodiment, the semiconductor chip is designed as a volume emitter. Electromagnetic radiation generated during operation of the semiconductor chip can be decoupled via a front side, a back side and via side surfaces of the semiconductor chip. The rear side is, for example, a side of the substrate facing away from the semiconductor layer sequence. The side surfaces of the semiconductor chip may be formed, for example, by side surfaces of the substrate.

The radiation generated during operation in the semiconductor layer sequence can be coupled out through the transparent, electrically conductive layer on the back side of the semiconductor chip. The radiation can be coupled out through the radiation-transmissive substrate on the front side and the side surfaces of the semiconductor chip.

According to an embodiment, the first contact and the second contact are arranged on the contact side between the electrically conductive layer. The electrically conductive layer is disposed closer to a respective side surface than the first and second contacts. The first contact and the second contact are arranged, for example, in a central region of the contact side. The transparent, electrically conductive layer extends in particular from the contacts to the side surface of the semiconductor chip. For example, an area ratio between 30% and 90% of the contact side is covered by the transparent, electrically conductive layer. In particular, the area ratio of the contacts is chosen to be as small as possible in comparison to the area ratio of the transparent, electrically conductive layer. However, the first and the second contact are at least chosen so large that a sufficient mechanical and/or electrical contact is possible. In particular, this is limited by tolerances during production. For example, the area ratio of the transparent, electrically conductive layer is between 30% and 50% of the contact side.

According to an embodiment, an optoelectronic component has a semiconductor chip according to at least one embodiment.

The optoelectronic component has, according to an embodiment, a carrier with a first and a second electrical conductor. The carrier is also referred to as a leadframe. The carrier is adapted to mechanically support the semiconductor chip. The carrier further provides an interface for electrically contacting the semiconductor chip. For example, the first and the second electrical conductor can be coupled to an external current/voltage source.

According to an embodiment, the first contact is electrically and mechanically coupled to the first conductor. The second contact is electrically and mechanically coupled to the second conductor. The semiconductor chip is thus held and supported mechanically by the carrier, in particular by means of the two contacts. In addition, the semiconductor chip is electrically contacted by means of the conductors and thus can be supplied with current/voltage.

According to an embodiment, the transparent, electrically conductive layer is at a distance from the carrier along a stacking direction of the semiconductor layer sequence. The stacking direction is aligned in particular along the vertical and can also be referred to as a growth direction. The transparent electrically conductive layer is not in contact with the carrier, in particular not in contact with the conductors of the carrier.

According to an embodiment, an optoelectronic component has a semiconductor chip according to at least one embodiment of this application. The optoelectronic component has a carrier with a first and a second electrical conductor. The first contact is electrically and mechanically coupled to the first conductor. The second contact is electrically and mechanically coupled to the second conductor. The transparent, electrically conductive layer has a spacing from the carrier along a stacking direction of the semiconductor layer sequence.

A semiconductor chip described and an optoelectronic component described are based, inter alia, on the following considerations. The metallic contacts of the semiconductor chip, which are formed for example of silver, and typical conductors of an optoelectronic component have a comparatively poor degree of reflection, in particular for radiation in the blue region. The low reflectance leads to optical losses and thus reduces the efficiency of the component.

The semiconductor chip described and the optoelectronic component described make use, among other things, of the idea that the metallic contacts are made smaller and are arranged in particular in the central region of the semiconductor chip instead of on whole surface of the semiconductor chip. The semiconductor chip is thus fastened on the conductors, for example by means of soldering, in such a way that the distance between the semiconductor chip and the conductors is formed, in particular outside the contacts of the semiconductor chip. A portion of the semiconductor chip thus remains free and radiation can decouple from the semiconductor chip at these points instead of being reflected by the full-surface metallization. Thus, losses can be avoided, which occur when the radiation is reflected directly on the chip. This radiation can be absorbed again in the semiconductor chip before leaving the semiconductor chip.

According to an embodiment, a converter for wavelength conversion is arranged between the transparent, electrically conductive layer and the carrier. For example, the semiconductor chip is designed to emit radiation in the blue wavelength range. The converter converts the radiation in the blue region to radiation in another wavelength range, for example in the green and/or red wavelength range. The converter comprises, for example, phosphorus. Due to the converter, which is arranged between the transparent, electrically conductive layer and the conductors, the radiation of the semiconductor chip is in particular converted before it hits the conductors. Thus, as little as possible radiation in the blue region hits the conductor but rather radiation in the green and/or red wavelength range. The radiation which hits the printed conductors is reflected by the printed conductors. The reflection properties of the printed conductors are better in the red and/or green wavelength range than in the blue wavelength range. In the green and/or red wavelength range, less radiation is absorbed by the conductors than in the blue wavelength range. Thus, during operation, more radiation is reflected from the conductors and less absorbed. Thus, the efficiency of the component is increased.

All in all, a smaller proportion of blue radiation must be reflected by the conductors and in the semiconductor chip. A greater portion of the radiation is converted before the radiation hits a reflective surface. The converted radiation has less reflection losses on the metallic conductors and contacts, which are made of silver, for example.

According to an embodiment, a further converter for wavelength conversion is arranged on one side of the substrate facing away from the contact side. For example, the converter and the further converter have mutually different concentrations of converter material. In particular, the concentration of the converter material in the converter between the transparent, electrically conductive layer and the conductors is higher than the concentration in the further converter. Radiation emitted towards the conductors is thus more likely to be converted. Thus, once again less radiation has to be reflected in the blue area. Radiation that is not emitted in the direction of the conductors, but, for example, in an opposite direction, is converted by the other converter, so that a little more blue radiation can be emitted unreflected. Consequently, in the other converter less conversion must take place, whereby the further converter is less heated.

For example, the converter and the other converter have the same materials but in different compositions. According to at least a further embodiment, the converter and the further converter have mutually different materials, for example different silicones and/or mutually different phosphors. Thus, it is possible to respond to the different conditions and in particular to realize different degrees of conversion.

According to an embodiment, the first and the second electrical conductors each have a recessed region in which the converter is arranged. Thus, it is comparatively easy to bring the converter between the transparent electrically conductive layer and the conductors.

According to an embodiment, the first and the second contact each have a projecting region, which is coupled to the respective conductor in order to form the distance to the carrier. For example, the projecting regions of the contacts are formed by electroplating. According to embodiments, the recessed region in the electrical conductors can then be dispensed with.

According to an embodiment, the first and the second conductors alternatively or additionally each have a projecting region, which is coupled to the respective contact in order to form the distance to the carrier. The two conductors have a kind of pedestal, so that the semiconductor chip in particular in the region of the transparent, electrically conductive layer has the distance to the conductors.

According to an embodiment, the semiconductor layer sequence, the first contact and the second contact are arranged between the substrate and the two electrical conductors along the stacking direction. The semiconductor layer sequence, the first contact and the second contact are thus facing the carrier. The substrate faces a main exit surface of the component.

The semiconductor chip and the component with the semiconductor chip thus have a higher efficiency, since a higher proportion of the radiation is converted before it is reflected. In addition, a higher proportion of converted radiation is reflected than radiation in the blue region. The converter between the semiconductor chip and the carrier can be cooled efficiently, in particular since the conductors are thermally conductive. Due to the smaller contact surface between the semiconductor chip and the conductors compared to conventional semiconductor chip mechanical stresses are reduced during operation. The mechanical stresses can also be reduced due to the projecting portions and/or the recessed portions.

Exemplary embodiments of the invention are explained in more detail below with reference to the schematic drawings, in which:

FIG. **1** shows a schematic view of a light-emitting semiconductor chip according to an exemplary embodiment,

FIG. **2** shows a schematic view of the front side of the semiconductor chip according to an exemplary embodiment,

FIG. **3** shows a schematic view of an optoelectronic component according to an exemplary embodiment,

FIG. **4** shows a schematic view of an optoelectronic component according to an exemplary embodiment,

FIG. **5** shows a schematic view of an optoelectronic device according to an embodiment, and

FIG. **6** shows a schematic view of the transmission properties of a transparent, electrically conductive layer according to an exemplary embodiment.

Elements of identical design or function may be identified by the same reference signs throughout the figures. The figures and the proportions of the elements shown in the figures are not to be considered to scale with each other.

FIG. **1** shows a schematic illustration of a light-emitting semiconductor chip **100** according to one exemplary embodiment. The light-emitting semiconductor chip **100** has a sheetlike extended substrate **101**. The substrate **101** is, for example, a sapphire substrate. The substrate **101** is in particular radiation-transmissive to electromagnetic radiation **109** which is generated by the light-emitting semiconductor chip **100** during operation. The substrate **101** has a semiconductor layer sequence **102** on a main surface **104**. The semiconductor layer sequence is in particular an epitaxially grown semiconductor layer sequence of indium gallium nitride. Other materials for the substrate **101** and the semiconductor layer sequence **102** are also possible.

The semiconductor layer sequence **102** has an active layer **103**, for example a pn junction. The semiconductor layer sequence **102** is configured to emit the electromagnetic radiation **109**, in particular in the blue spectral range.

On a side **114** of the semiconductor layer sequence **102** facing away from the substrate **101**, a first contact **105** and a second contact **106** are formed. The first and the second contact **105**, **106** are used in particular for the electrical and mechanical contacting of the semiconductor chip **100**. By means of the first and the second contact **105**, **106**, it is possible to apply an electrical voltage to the semiconductor layer sequence **102**, so that the radiation **109** is emitted. For example, the first contact **105** has a contact layer **115**. The contact layer **115** has one or more dielectric layers and metal layers. In particular, the contact layer **115** has layers of silver. The contact layer **115** is formed in particular reflective.

The contacts **105**, **106** are each arranged in a middle region **113** of the semiconductor chip **100**. The contacts **105**, **106** do not extend in the lateral direction along the contact side **114** all the way to side surfaces **112** of the semiconductor chip **100**. The side surfaces **112** each extend in particular along a stacking direction **204**, which runs in particular vertically. The side surfaces **112** extend along the stacking direction **204** between a rear side **111** of the semiconductor chip **100**, which faces away from the semiconductor layer sequence **102**. A front side **110** of the semiconductor chip lies opposite the rear side **111**.

The contacts **105** and **106** do not completely cover the contact side **114**. The contacts **105** and **106** only partially cover the semiconductor layer sequence **102**, in particular the contact side **114**. A region of the semiconductor layer sequence **102**, in particular the contact side **114**, is free of the reflective contacts **105**, **106**.

The areas of the contact side **114** that are not covered by the contacts **105**, **106** are covered by a transparent, electrically conductive layer **107**. The transparent electrically conductive layer **107** is electrically connected to the first contact **105**. The second contact **106** is in particular electrically connected to an opposite side of the semiconductor layer sequence **102**, for example by means of plated-through holes (not explicitly shown), also called vias. Correspondingly, the second contact **106** is electrically insulated from the first contact **105** and the electrically conductive layer **107**. Electrical current, which flows to the contacts **105**, **106** during operation, flows at least partially further into the layer **107** and from there to the semiconductor layer sequence **102**. The layer **107** thus serves as a current spreading layer in order to contact the semiconductor layer sequence **102** as fully as possible electrically.

The transparent, electrically conductive layer **107** is transmissive in particular to the electromagnetic radiation **109** that is generated in the semiconductor layer sequence **102**. For example, the layer **107** is formed of indium tin oxide.

The semiconductor chip **100** is thus designed as a volume emitter. The radiation **109** leaves the semiconductor chip **100** on the front side **110** through the layer **107**, on the rear side **111** and on the side surfaces **112**. Only in the middle region **113** of the front side **110**, in which the metallic contacts **105**, **106** are arranged, the radiation is not emitted.

FIG. **2** shows a plan view of the front side **110** of the semiconductor chip **100** according to one exemplary embodiment. The contacts **105**, **106** are arranged in the central region **113**. The contacts **105**, **106** form only part of the front side **110**. Outside the contacts **105**, **106**, the layer **107** is formed. The layer **107** surrounds the contacts **105**, **106** on the front side **110**. In particular, the contacts **105**, **106** cover a range between 20% and 50% of the front side **110**. The metallic contacts **105** and **106** are formed as small as possible, but still one sufficient thermal conductivity and mechanical handling remains. For example, the contacts **105**, **106** are about 150 to 200 microns wide and 200 to 300 microns long in a 1×1 mm^2 large semiconductor chip **100**.

FIG. **3** shows a schematic representation of an optoelectronic component **200** according to an exemplary embodiment. The component **200** has the light-emitting semiconductor chip **100** according to at least one embodiment.

The semiconductor chip **100** is electrically and mechanically connected to printed conductors **202**, **203** of a carrier **201** by means of the contacts **105**, **106**, for example by means of soldering.

The carrier **201** serves both to support the semiconductor chip **100** and to provide an electrical interface for the electrical contacting of the semiconductor chip **100**. The first electrical conductor **202** is in particular connected to the first contact **105**. The second electrical conductor **203** is in particular connected to the second contact **106**. The conductors **202**, **203** are, for example, copper conductors, which are coated with silver. The conductors **202** and **203** are formed in particular reflective, as will be explained in more detail below.

In the exemplary embodiment shown, the printed conductors **202**, **203** each have a projecting region **215**. With regard to the lateral main propagation direction of the conductors **202**, **203**, the regions **215** respectively project vertically against the stacking direction **204**. The electrical and mechanical contact with the contacts **105**, **106** is formed on the projecting regions **215**. Thus, the semiconductor chip is arranged outside the projecting regions **215** at a distance **205** from the printed conductors **202**, **203**. In particular, the outside of the layer **107** facing away from the semiconductor layer sequence is arranged at a distance from the printed conductors **202**, **203**. Thus, the radiation **109** may also exit at the front side **110** of the chip **100** before being reflected by the conductors **202**, **203**.

The component **200** has a main exit area **216** from which, in operation, the radiation is mainly intended to leave the component **200**. The main exit area **216** faces away from the carrier **201** and the conductors **202**, **203**. Due to the distance **205** and the transparent layer **107**, radiation **109** can initially leave the semiconductor chip **100** in the direction of the carrier **201** and is only subsequently reflected in the direction of the main exit area **216**. Compared to semiconductor chips, in which the contact side **114** is completely metallized in order to reflect the radiation directly in the direction of the main exit surface, thus lower absorptions occur in the semiconductor chip **100** itself, since the radiation **109** can leave the semiconductor chip **100** on the front side **110** unreflected.

The component **200** has a converter **206** which surrounds the semiconductor chip **100**. In particular, the converter **206** is also arranged on the transparent, electrically conductive layer **107**. The converter **206** is arranged in particular along the stacking direction **204** between the semiconductor chip **100** and the conductors **202**, **203**. The converter **206** has in particular a converter material which converts the radiation **109** into radiation **210**, **211** with a wavelength which is different from the radiation **109**. For example, the converter comprises phosphorus which is in a silicone **209**.

For example, the converted radiation **210** has a wavelength in the red region. The converted radiation **211** has, for example, a wavelength in the green range.

As shown by the example of the converted radiation **210**, at least part of the radiation **109** is converted before it is reflected by the conductor **202** or the conductor **203** in the direction of the main exit surface **216**. The example of the converted radiation **211** shows that part of the radiation **109** is already aligned by the conversion in the direction of the main exit surface **216**.

Metals, for example silver, aluminum or gold, have wavelength-dependent reflection properties. In the blue region **301**, the reflectivity is lower, in particular in the case of silver, than in the green region **302** and in the red region **303** (FIG. **6**).

Due to the use of the transparent, electrically conductive layer **107** and the arrangement of the semiconductor chip **100** at a distance **205** from the reflective conductors **202**, **203**, a large proportion of blue radiation **109** leaves the semiconductor chip **100**. There are fewer absorption losses in the semiconductor chip **100** itself, since the absorption in the chip for the radiation **210** and **211** in the green and red regions is less than for the radiation **109** in the blue region.

Overall, only a minor portion of the emitted radiation **109** must be reflected by a metallic surface or a metallic mirror. As shown by the example of the converted radiation **210** and **211**, there is a high probability that the radiation **109** will be converted before it reaches a reflective surface. In addition, the reflective properties of the conductors **202**, **203** are better for the converted radiation **210** and **211** than for the radiation **109**. It is thus possible that radiation leaving the chip **100** at the front **110** need not be reflected at all, as shown in the example the radiation **211**. Radiation exiting the chip **100** at the front side **110** is also highly likely to be converted before it is reflected on the conductors **202**, **203**, as shown by the example of the radiation **210**.

Due to the distance **205** between the chip **100** and the conductors **202**, **203**, the converter **206** between the chip **100** and the carrier **201** is sufficiently cooled, in particular due to the thermal conductivity of the conductors **202**, **203**. This contributes to a long life of the device **200**.

In addition, the projecting regions **215** reduce mechanical stresses within the component **200** and the semiconductor chip **100**. The contact area between the conductors **202**, **203** and the contacts **105** and **106** is reduced, in particular in comparison to conventional full-surface contacts **105**, **106**.

The component **200** thus enables a higher efficiency, since reflection losses or absorption at metallic reflectors (also called mirrors) are reduced.

FIG. **4** shows the optoelectronic component **200** according to a further exemplary embodiment. The component **200** essentially corresponds to the component **200**, as explained in connection with FIG. **3**. In contrast, in addition to the converter **206**, a further converter **207** is provided. The further converter **207** is arranged, in particular, on a side **208** of the substrate **101** facing away from the printed conductors **202**, **203**. The further converter **207** covers, for example, the rear side **111** and the side surfaces **112** of the chip **100**. The further converter **207** has, for example, a lower concentration of phosphorus than the converter **206**. According to further embodiments, the converter **206** and the further converter **207** have mutually different materials, for example, different silicones **209** and/or different phosphors.

In the embodiment of FIG. **4** the converter **206** is arranged along the stacking direction **204** between the semiconductor chip **100** and the conductors **202**, **203**. The radiation **109**, which leaves the semiconductor chip **100** in the direction of the conductors **202**, **203**, is thus converted with a higher probability. Radiation exiting the semiconductor chip **100** at the side surfaces **112** and the backside **111** is converted with less probability. Thus, the effect can be amplified that radiation which must be reflected by the conductors **202**, **203** to the main exit surface **216**, is preferably converted. The radiation exiting the chip on the front side **110** is therefore preferably converted rather than just reflected. For example, it is possible for the further converter **207** to convert, above all, into the green range. The converter **206** preferably converts to the red area. Thus, it is exploited that the reflective properties of the conductors **202**, **203** in the red area **303** (FIG. **6**) are even better than in the green area **302**. In addition, since phosphor for conversion to the red region becomes hotter according to embodiments, the thermal advantage due to cooling by means of the conductors **202**, **203** is exploited. In addition, radiation from converter **206** located below may be converted to the green region without absorption or with only slight absorption by the further converter **207**. This reduces the likelihood that a phosphor that converts to the red region absorbs radiation in the green region.

For the arrangement of the converter **206**, the conductors **202**, **203** each have a recessed region **213**. The recessed region **213** is reset in particular vertically. Thus, by means of the projecting region **215** and the recessed regions **213**, it is possible to form the distance **205** so that the converter **206** can be disposed between the semiconductor chip **100** and the conductors **202**, **203**. The distance **205** is in particular between 50 and 100 μm. In particular, the size of the distance **205** depends on the particle size used. The distance **205** is at least so great that the particles of the converter **206**, that is to say in particular the phosphor particles, can pass sufficiently well between the semiconductor chip **100** and the conductors **202**, **203**. For example, the converter **206** and the further converter **207** are formed as separate pottings. First, the potting for the converter **206** is applied so as to flow between the semiconductor chip **100** and the conductors **202**, **203**. Subsequently, the potting for the further converter **207** is applied.

The projecting regions **215** are, for example, each about 100 μm high, in particular in a range between 50 μm and 200 μm high, so that a corresponding distance **205** is formed. The protruding areas **215** each have, for example, a width **217** between 200 μm and 300 μm.

FIG. **5** shows the optoelectronic component **200** according to a further embodiment. The exemplary embodiment of FIG. **5** substantially corresponds to the exemplary embodiments of FIGS. **3** and **4**. In contrast, the printed conductors **202**, **203** have no projecting region **215** and no recessed region **213**. Instead, the contacts **105** and **106** are each formed with a protruding region **214** to realize the distance **205** between the semiconductor chip **100** and the conductors **202**, **203**. The projecting regions **214** are, for example, electrodeposited on the contact layer **115** with a vertical height of 100 μm or more.

According to further embodiments, a combination of the projecting regions **214** of the contacts **105**, **106** and the projecting regions **215** of the conductors **202**, **203** is also possible.

FIG. **6** shows the radiation transmittance or transmission **307** of the transparent, electrically conductive layer **107** as a function of the wavelength on the example of indium tin oxide. In the blue region **301**, less radiation is transmitted and more radiation is absorbed than in the green region **302** and in the red region **303**. Consequently, the absorption losses for the radiation that has to pass again from the carrier **201** through the chip **100** to the main exit surface **216** are lower, as shown in FIG. **3** using the example of the converted radiation **210**. Before the radiation transmits a second time through the transparent electrically conductive layer **107**, it is converted to the green or red region in which the transmission is higher and the absorption is lower.

Overall, therefore, the need to reflect radiation **109** in the blue region is reduced. In particular, it is possible to deflect radiation in the direction of the main exit surface **216** without having to reflect it. Radiation that has to be reflected, in particular, is reflected only after the conversion. Since the converted radiation is reflected better than the unconverted radiation **109**, overall less absorption losses occur. Overall, therefore, an efficient and long-lasting stable semiconductor chip **100** or a corresponding optoelectronic component **200** can be realized.

The description with the aid of the exemplary embodiments does not limit the invention thereto. Rather, the invention comprises any new feature and any combination of features, which in particular includes any combination of features in the patent claims, even if this feature or this combination is not itself explicitly stated in the patent claims or exemplary embodiments.

The invention claimed is:

1. A light-emitting semiconductor chip, comprising:
- a radiation-transmissive substrate,
- an epitaxially grown semiconductor layer sequence on a main surface of the substrate,
- a first contact and a second contact on a contact side of the semiconductor layer sequence facing away from the substrate for electrical and mechanical contacting of the semiconductor chip,
- a transparent, electrically conductive layer which is arranged on the contact side and is electrically connected to the first contact.

2. The semiconductor chip according to claim **1**, which is designed as a volume emitter, so that during operation of the semiconductor chip generated electromagnetic radiation is decupled via a front side, a back side and side surfaces of the semiconductor chip.

3. The semiconductor chip according to claim **1**, wherein the first contact and the second contact are disposed on the contact side between the transparent electrically conductive layer.

4. The semiconductor chip according to claim **1**, wherein the first contact and the second contact are each arranged in a central region of the contact side.

5. The semiconductor chip according to claim **1**, wherein an area ratio between 30% and 90% of the contact side is covered by the transparent, electrically conductive layer.

6. An optoelectronic component, comprising:
- a semiconductor chip comprising:
  - a radiation-transmissive substrate,
  - an epitaxially grown semiconductor layer sequence on a main surface of the substrate,
  - a first contact and a second contact on a contact surface of the semiconductor layer sequence facing away from the substrate for electrical and mechanical contacting of the semiconductor chip,
  - a transparent, electrically conductive layer which is arranged on the contact side and is electrically connected to the first contact,
- a carrier having a first electrical conductor and a second electrical conductor, wherein
  - the first contact is electrically and mechanically coupled to the first conductor and the second contact is electrically and mechanically coupled to the second conductor, and
  - the transparent, electrically conductive layer has a distance to the carrier along a stacking direction of the semiconductor layer sequence.

7. The component according to claim **6**, wherein a converter for wavelength conversion is arranged between the transparent, electrically conductive layer and the carrier.

8. The component according to claim **7**, comprising a further converter for wavelength conversion, which is arranged on a side of the substrate facing away from the contact side.

9. The component according to claim **8**, wherein the converter and the further converter have mutually different concentrations of converter material.

10. The component according to claim **8**, wherein the converter and the further converter comprise mutually different materials.

11. The component according to claim **7**, wherein the first electrical conductor and the second electrical conductor each are configured to be reflective for converted radiation.

12. The component according to claim **7**, wherein the first electrical conductor and the second electrical conductor each comprise a recessed region, in which the converter is arranged.

13. The component according to claim **6**, wherein the first contact and second contact each have a projecting region coupled to the respective track to form the distance to the carrier.

14. The component according to claim **6**, wherein the first electrical conductor and second electrical conductor each have a projecting region coupled to the respective contact to form the distance to the carrier.

15. The component according to claim **6**, wherein the first contact and the second contact are arranged between the substrate and the two electrical conductors along the stacking direction.

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